Experimental Approach to Effective Implementation of Non-Compete Agreements

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Abstract

Although Non-Compete Agreements (NCAs) are widely used in employment contracts to prevent ex-employees from competing against their former employers, theoretical models and empirical studies have struggled to quantify their impact on the labor market. To study the effects of NCA enforcement policies on matching and separating decisions of firms and workers, a laboratory experiment was designed and conducted. The behaviors of economic agents and their impact on economic performance were compared under three policies: (1) firms were prohibited from using NCAs; (2) firms could impose NCAs after workers accepted a job offer and without prior disclosure; and (3) firms were required to disclose NCA requirements in the job offer. Under the prohibition of NCAs, the workers engaged in opportunistic behaviors and frequently changed employers in pursuit of better compensation. Consequently, the firms faced significant turnover costs. On the contrary, when NCAs were imposed on the workers without prior disclosure, firms tended to use unnecessary NCAs. In result, the workers suffered from decreased economic return. Mandatory ex-ante disclosure of NCA requirements overcame the shortcomings of the two extreme NCA policies: it provided the firms with the means to mitigate the investment risk while allowing the potential employees to impel firms to use NCAs only when necessary. If the NCA policy has comparable effects on the matching and separating decisions of workers and firms in the real world, the optimal NCA usage can be achieved through self-correcting markets. Mandatory ex-ante disclosure of NCA requirements is a potential solution to the struggles faced by states of maintaining and enforcing convoluted statutes regarding NCAs. It can also save significant amounts of time and money currently lost in litigation.

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I. Introduction

An NCA is a contract under which one party (usually an employee) agrees not to start a business or work for other firms in competition against another party (usually an employer). Although NCAs are widely used in employment contracts to prevent ex-employees from competing against their former employer, theoretical models and empirical studies have struggled to quantify the impact of NCAs on the labor market. In this study, an experiment was conducted to examine how NCA enforcement policies affect the matching and separation decisions of firms and workers. The decisions of workers and firms and their impact on economics outcomes were compared across three NCA treatments: firms were prohibited from using NCAs (No-NCA treatment); firms could impose NCAs after workers accepted a job offer and without prior disclosure (Ex-Post NCA treatment); and firms were mandated to disclose NCA requirements in the job offer (Ex-Ante NCA treatment). Currently, approximately 30 states rule that continuous employment constitutes enough consideration for an NCA to be enforceable. Other states require a pay raise, promotion, or similar act for the contract to be valid.

The mechanism through which NCA enforcement policies affect economic outcomes is depicted in **Figure 1**. The NCA policy directly affects investment decisions made by firms. When a policy prohibits NCAs, firms with high hiring and training costs are unwilling to invest in their employees because they may not be able to collect economic returns on their investment should their employees leave the company. Consequently, there are more foregone employment opportunities and potentially a higher rate of unemployment. The unemployment rate is also affected by worker's willingness to work.

Firms adjust their strategy on NCA usage according to the ability of potential workers to punish excessive usage of NCAs. When the policy requires ex-ante disclosure of NCA requirements, firms are more cautious about using an NCA because it can alienate potential workers. In turn, the presence or absence of an NCA in an employment relationship affects the productivity of the worker. There are two opposing forces. On the one hand, workers who are bound by an NCA may feel less loyal toward their employers (because the employers imposed a financial burden on the workers), and consequently, workers may put less effort in work. On the other hand, workers may work harder when bound by an NCA out of the fear of being laid off and having to abide by the NCA after the termination of the employment. Because an NCA limits the ability of the worker to earn economic rent on their skills during the subsequence employments, NCAs are expected to discourage workers from quitting.

The decisions of workers to quit and the decisions of firms to fire determine the labor mobility rate. As more workers freely seek for better employment opportunities and change their jobs, the labor mobility rate increases. With greater labor mobility, the overall match quality between workers and firms is expected to improve. However, a higher labor mobility rate also increases the transaction costs spent on searching, moving, hiring, and training. Ultimately, the social surplus is determined by the unemployment rate, worker productivity, overall match quality, and the amount of transaction costs.

It was hypothesized that when firms are allowed to use NCAs, the gains from reduced unemployment rate and transaction costs outweigh the losses from reduced labor mobility and match quality. Furthermore, when firms are allowed to impose NCAs after workers have accepted a job offer, firms base their NCA decisions solely on their welfare, and therefore, the losses from reduced labor mobility are overlooked. As a consequence, the losses from reduced labor mobility can exceed the gains from decreased transaction costs. In contrast, when firms must disclose NCA requirements in the job offer, workers can compel firms to incorporate the losses from reduced labor mobility in their NCA decision making.

In this study, the following hypotheses were tested: (1) Under the Ex-Post and Ex-Ante NCA policies, more firms hire workers because they can mitigate the risk of losing on the hiring cost by imposing NCAs and discouraging workers from quitting; (2) Under the Ex-Ante NCA policy, firms with a low hiring cost impose NCAs less frequently than under the Ex-Post NCA policy because imposing an NCA may deter potential workers; (3) Workers are less likely to quit when bound by an NCA; and (4) Social surplus is maximized under the Ex-Ante NCA policy because it balances the gains from decreased transaction costs and losses from decreased worker mobility.

Figure 1. How NCA Policy Affects Decisions of Economics Agents and Economic Outcomes

II. Background

The duality of the economic impacts of NCAs has been a compelling topic in the literature. First, such contracts reduce labor mobility and, in result, may harm the economy by restricting opportunities to improve the compatibility between workers and firms (e.g., Hyde (1998) and Gilson (1999)). Second, such contracts encourage human capital investment and facilitate technological advancement (e.g., Rubin and Shedd (1981) and Lester (2001)). Because the net effect of NCAs on the economy is unclear, the enforceability of such contracts significantly varies across states in the U.S.: some states ban NCAs (e.g., California and North Dakota) while others recognize the broad protectable interests of employers (e.g., Florida and Kansas).

A few empirical studies have been performed on the effect of NCAs on labor mobility. Using data from the Current Population Survey, Fallick, Fleischman, and Reibitzer (2006) found higher rates of job-hopping in IT clusters for college-educated males in California than in IT clusters located outside the state. Because the mobility rate in other industries in California is similar to that of other states, the results support the hypothesis suggested by Gilson (1999) that the unenforceability of NCAs under California state law enhances the benefits from the clustering of IT industry and outweigh the loss from knowledge spillover. However, as the authors admit, the results can be attributed to unobserved features of California-based IT firms rather than the effect of NCA non-enforceability. One of the difficulties in analyzing the effect of NCAs on labor mobility using empirical data is that the effect of NCAs on labor mobility is confounded with the state effect. In other words, because the NCA enforcement laws are state-specific, a model cannot determine whether the differences in mobility rates among states are attributable to the differences in NCA enforcement laws or other state-specific characteristics such as demography, state tax rate, and industry type and scale.

Opportunities for a natural experiment were provided by Michigan's inadvertent 1985 reversal of its NCA enforcement policy. Marx, Strumsky, and Fleming (2009) used the U.S. patent database to study the change in the labor mobility rate. Using a difference-in-difference approach, they found that NCA enforcement reduces labor mobility. Although this evidence is more convincing than the cross-sectional study on the California IT clusters, one cannot rule out the possibility that there was an unobserved event specific to Michigan in 1985 that drove the result. Moreover, as the authors admit, patent data have a variety of documented weaknesses, namely, that many inventors do not seek patents and that many patents take years to process. Instead of relying on existing data, Marx (2011) interviewed 52 randomly sampled patent holders in the automatic speech recognition industry and revealed that ex-employees subject to NCAs are more likely to leave their technical field to avoid a lawsuit.

Although there is some evidence to support the claim that NCA enforcement reduces labor mobility, given the limited number of studies and an inherent inability of empirical studies to separate the effects of NCA laws and other state-specific characteristics, one cannot confidently conclude NCA enforcement harms the economy. In addition, although there are well-established theories trying to assess the effect of NCA enforcement on human capital investment (e.g., Bishara (2006)), the reliability of such theories is highly uncertain due to the lack of evidence.

Despite the complexity of the NCA laws, NCAs can improve economic efficiency when properly implemented. Posner, Triantis, and Triantis (2004) showed that NCA can simultaneously optimize labor mobility and human capital investment when the scope of NCAs is properly chosen. This is possible because NCAs—a hybrid of specific performance (a promise to work for a specific firm) and liquidated damages (payment from one party to another upon a breach of a contract)—can cancel the over-

investment effect of specific performance and the under-investment effect of liquidated damages. This result suggests that states have leverage to induce the right amount of incentive for human capital investment without severely restricting labor mobility. Furthermore, Fulghieri and Sevilir (2008) showed that imposing NCAs on employees adversely affects innovation incentives and reduces firm profit and that firms can gain a strategic advantage over their rivals by not imposing NCAs. Thus, in competitive industries, firms will voluntarily refrain from imposing NCAs on their employees when the costs incurred by reduced innovation incentives outweigh the benefits of retaining skilled employees.

As the state of the literature indicates, there is, and there will be, very limited data available for the evaluations of the validity of existing theoretical models. In addition, ambiguities in NCA laws make economic analyses difficult to conduct. For example, Bishara (2010) used a scale of 0 to 10 to measure the favoring or disfavoring of NCA enforcement by analyzing the questions in Richey and Malsberger (1991), whereas Garmaise (2011) assigned a score of 1 if enforcement of a certain dimension of NCA law exceeds a threshold and 0 otherwise. In both studies, the scores were aggregated to obtain a single index of favorability of NCA enforcement for each state. Because NCA laws cover a broad range of aspects of NCA enforcement, from employer's protectable interests to courts' right to modify contracts to render them enforceable, a large amount of information is lost by the aggregation. However, this is inevitable in quantitative analysis due to the limitation of data availability and the existence of collinearity among the favorability of enforcement on different aspects of NCA laws.

This study aims to assess the impact of the timing of NCA requests on the decisions made by economic agents. Instead of micro-regulating every aspect of NCA laws, one can grant more bargaining power to workers by mandating firms to disclose NCA requirements in the job advertisements and facilitate self-policing of NCA usage. If a socially efficient outcome can be achieved through self-correcting markets, states would have no need to amend or enforce convoluted statutes regarding NCAs, saving significant amounts of time and money.

III. Methodology

A laboratory experiment was conducted in which participants played a labor-market game. The game was designed to measure the impact of the NCA policies on the decisions made by workers and firms in the labor market and the resulting economic outcomes. The three NCA policies analyzed in this study were as follows: (1) firms were prohibited from using NCAs (No-NCA treatment); (2) firms could impose NCAs after workers accepted a job offer and without prior disclosure (Ex-Post NCA treatment); and (3) firms were required to disclose NCAs in the job offer (Ex-Ante NCA treatment). The critical aspects of the experiment are outlined in this section. For more details, refer to the instructions in Appendix A through C.

Upon arriving at the laboratory, participants were randomly assigned one of three roles: a worker with a low job-change cost (20 points), a worker with a high job-change cost (150 points), or a firm. Each firm had two positions that it could offer in the labor market: one with a low hiring cost (20 points) and one with a high hiring cost (150 points). There were eight workers and four firms in each session.

At the beginning of each round, firms decided whether or not to offer each position in the labor market, and if offering, whether or not to impose an NCA (if the policy allowed imposing NCAs). Firms had to make the same offer to every worker in the market. Under the Ex-Post NCA treatment, firms were not allowed to disclose the NCA requirements, whereas under the Ex-Ante NCA treatment, all firms were

required to disclose the NCA requirements. Under the Ex-Ante NCA treatment, workers observed which positions imposed NCAs.

During the matching, the workers were asked to list the possible actions in order of their preferences. In other words, workers prepared a contingency plan. Each worker received a signal from each position submitted in the market. The signal provided some information about the match quality of the potential job. Under the No-NCA and Ex-Post NCA treatments, workers ranked the following options: take a position with a good signal, take a position with a bad signal, and remain unemployed. Under the Ex-Ante NCA treatment, workers ranked the following options: take a position with a good signal that imposed "Contract X" (in the instructions, an NCA was referred to as Contract X), take a position with a bad signal that imposed Contract X, take a position with a good signal that did not impose Contract X, take a position with a bad signal that did not impose Contract X, and remain unemployed. A computer sequentially matched a position to each worker according to the preference of the worker. The matching began with the most productive worker and ended with the least productive worker.

After the matching of workers and positions was complete, the employed workers performed slider tasks to earn points for themselves and for their employers. The slider task was first developed and used by Gill and Prowse (2012) and has been employed in many studies to measure the effort level.

At the end of each round, the firms and the workers independently decided whether or not to retain their current employment relationship(s). The employment continued only when both the worker and the firm chose to continue the employment. In addition, all employment relationships were subject to random termination with probability 1/10.

To create levels of incentive for players to search for new employment, a computer randomly assigned either a "good match" or a "bad match" to each potential match. On average, there was one good match for every four bad matches. If a pair was a good match, the rate for the slider tasks was 25 points per slider with probability 4/5 and 5 points per slider with probability 1/5. If a pair was a bad match, the rate for the slider tasks was 25 points per slider with probability 1/5 and 5 points per slider with probability 1/5. The rate was randomly drawn from these distributions for each worker-position pair in each period.

The underlying match quality was unknown to workers and firms. However, workers received an imperfect signal from each position before accepting an offer: if a pair was a good match, the signal was good with probability 4/5 and bad with probability 1/5; if a pair was a bad match, the signal was good with probability 1/5 and bad with probability 4/5. In addition, both workers and firms obtained information about the true match quality gradually over time through signals that set the rate for the slider tasks in each period.

When a worker signed an NCA, his or her piece rate for the slider tasks was fixed at 5 points per slider during the three rounds that immediately followed the termination of the employment regardless of the signals they received. This can be interpreted as the worker taking a job outside of his specialized area due to an NCA that prevents the worker from working for a competitor of his or her former employer. Neither the profit rate of a new employer nor that of the former employer who imposed the NCA was affected. The piece rate for a worker and the profit rate for a firm were determined by the signal they received, and therefore, there was no bargaining over the piece rate between the worker and the firm.

The set of matching, slider tasks, and separation was repeated twelve times, with the employment status carrying over from one round to the next. Each session consisted of two treatments, and the role of the participants remained the same throughout the session. There were fifteen sessions in total, involving 180 participants. The potential participants were randomly selected from the subject pool maintained by

the Experimental Economics Laboratory at The Ohio State University and were contacted through an email invitation. Each session lasted about 1.5 hours and the participants were paid 19.01USD on average, including a show-up fee of 5.00 USD. The conversion rate was 1.00 USD for every 100 points for workers and 1.00 USD for every 200 points for firms. One treatment was randomly chosen at the end of each session to determine the final payoff. The experiment was programmed and conducted with the experiment software z-Tree v3.4.7 (Fischbacher, 2007).

Of the fifteen sessions, the first four were conducted on a "slow server," on which z-Tree slowed down and sporadically froze. The remaining eleven sessions were conducted on a "fast server," on which z-Tree ran smoothly. The switching from the slow server to the fast server required an adjustment of the slider task duration to account for the increased processing speed. The slider task duration was 60 seconds for the sessions conducted on the slow server and 45 seconds for the sessions conducted on the fast server. The schedule of the sessions is shown in **Table 1**.

Table 1. Session Schedule

Session	First Treatment	Second Treatment	Date	Start Time	Server
1	Ex-Post NCA	No NCA	2/24/2015	16:15	Slow
2	Ex-Ante NCA	Ex-Ante NCA	2/26/2015	9:30	Slow
3	Ex-Ante NCA	No NCA	3/2/2015	15:15	Slow
4	No NCA	Ex-Post NCA	3/3/2015	14:15	Slow
5	Ex-Ante NCA	Ex-Post NCA	3/9/2015	15:15	Fast
6	Ex-Post NCA	Ex-Ante NCA	3/10/2015	14:15	Fast
7	No NCA	Ex-Ante NCA	3/13/2015	13:00	Fast
8	Ex-Ante NCA	Ex-Post NCA	3/26/2015	16:00	Fast
9	Ex-Post NCA	No NCA	3/31/2015	16:00	Fast
10	No NCA	Ex-Ante NCA	5/12/2015	12:30	Fast
11	Ex-Post NCA	Ex-Ante NCA	5/13/2015	12:30	Fast
12	No NCA	No NCA	5/14/2015	12:00	Fast
13	No NCA	Ex-Post NCA	5/14/2015	16:00	Fast
14	Ex-Ante NCA	No NCA	5/15/2015	10:00	Fast
15	Ex-Post NCA	Ex-Post NCA	5/15/2015	13:00	Fast

IV. Results

IV.A. Invest Decisions

In this experiment, the willingness of a firm to invest in human capital was measured by a submission of an available position in the labor market. This choice was made to avoid over-complication of the experimental design. The hiring-cost incurred by the firms can be interpreted as training costs to equip their workers with skills necessary for the job. **Table 2** shows the total number of non-investments (hold-back of an available position) and investments (submission of an available position in the labor market) along with the proportion of investments. For the low-cost positions, the investment rate was near 100% under all treatments. This was expected because firms could almost certainly recover the

investment costs in one round. For the high-cost positions, during the first treatments, Ex-Post and Ex-Ante NCA treatments had a higher rate of investments than the No-NCA treatment. This was expected because firms could mitigate the risk on investment by using an NCA.

Table 2. Summary of Investment Decisions Made by Firms

(a) Low-Cost Position

Treatment	Treatment Order	Do not invest	Invest	% Invest
No NCA	First	1	82	98.80
Ex-Post NCA	First	2	73	97.33
Ex-Ante NCA	First	0	71	100.00
No NCA	Second	0	75	100.00
Ex-Post NCA	Second	0	79	100.00
Ex-Ante NCA	Second	0	72	100.00

(b) High-Cost Position

Treatment	Treatment Order	Do not invest	Invest	% Invest
No NCA	First	77	63	45.00
Ex-Post NCA	First	48	58	54.72
Ex-Ante NCA	First	32	62	65.96
No NCA	Second	22	61	73.49
Ex-Post NCA	Second	22	65	74.71
Ex-Ante NCA	Second	57	47	45.19

However, during the second treatment, the investment rate was lower for the Ex-Ante NCA treatment. An analysis of the investment decisions at the individual level identified three subjects who held back the high-cost position throughout the treatment. Such subjects were found only under the Ex-Ante NCA treatment that was conducted as the second treatment of the session. It turned out that the lower investment rate for the second Ex-Ante NCA treatment was a reaction to the negative returns on the investments the subjects experienced during the first treatment.

To test the hypothesis that allowing the usage of NCAs encouraged investments, logistic regression models were fitted for the investment decisions made by firms. The first No-NCA treatment was taken to be the baseline case. The estimates of the treatment effect on the investment decisions were controlled for the points earned during the first treatment. The coefficient estimates are shown in **Table 3**. Model (1) and (3) include the points from the first treatment, while model (2) and (4) include a dummy variable for the net negative points from the first treatment. The points were divided by 100 to make the interpretation more intuitive. To account for the lower expected returns from the investments in the later rounds, the dummy variable for each round were included in model (1) and (2), and the quadratic trend was included in model (3) and (4). To avoid a small minority of subjects influencing the coefficient estimates, weights were used equal to the reciprocal of the number of times each firm made the investment decisions for each position.

Table 3. Coefficient Estimates from Logit Investment Decision Models for High-Cost Positions

Model	(1)	(2)	(3)	(4)
Round Effect	Dummy	Dummy	Quadratic	Quadratic
First Treatment Ex-Post NCA	0.378	0.378	0.365	0.365
	(0.305)	(0.305)	(0.299)	(0.299)
First Treatment Ex-Ante NCA	1.280‡	1.280‡	1.266‡	1.266‡
	(0.325)	(0.325)	(0.321)	(0.321)
Second Treatment	–1.823†	–0.965	1.954‡	2.862‡
	(0.918)	(0.842)	(0.706)	(0.713)
Second Treatment Ex-Post NCA	0.247	0.416	0.154	0.302
	(0.475)	(0.450)	(0.470)	(0.441)
Second Treatment Ex-Ante NCA	–0.790*	−0.647	–0.768*	–0.659
	(0.413)	(0.402)	(0.410)	(0.401)
Points from the First Treatment	0.129‡	-	0.125‡	-
	(0.029)	-	(0.028)	-
Negative Points	-	–1.070†	-	–1.049‡
	-	(0.422)	-	(0.398)
Number of observations	614	614	614	614

Shown in the table are the estimated log odds ratios from a logit regression of investment along with standard errors inside parentheses. The baseline case is the first No-NCA treatment. The dummy variables for each round were included in model (1) and (2), and the quadratic trend was included in model (3) and (4). The points from the first treatment were divided by 100 to make the interpretation more intuitive. Weights were used equal to the reciprocal of the number of times each firm made the investment decisions for the high-cost position. The symbols *, †, and ‡ indicate significance at the 10, 5, and 1% level, respectively.

For the first treatment, all models indicate the odds of investing in the high-cost position under the Ex-Ante NCA treatment were about 3.5 times the odds under the NCA treatment. This is consistent with the hypothesis that NCAs encourage the investments. For every 100 points firms earned during the first treatment, the odds of investing in the high-cost position during the second treatment increased by about 13%. The odds of investing in the high-cost position for the firms that had a net negative return from the first treatment were about 0.35 times the odds for the firms that had a net positive return. When controlled for the net negative return from the first treatment, the lower investment rate under the second Ex-Ante NCA treatment became insignificant.

IV.B. Preference of Workers

Employment decisions made by workers were also affected by the treatments. **Table 4** shows the percentage of the contingency plans submitted by the workers that indicated the preference for unemployment over alternatives. For the low-cost positions, almost all workers preferred taking a position with a good signal to unemployment. The proportion of the contingency plans that indicated the preference for unemployment over a position with a bad signal was higher for the Ex-Post NCA treatment than that for the No-NCA treatment, which suggests that NCAs discourage workers from working. For the high-cost positions, the probability of preferring unemployment to taking a position increased

significantly under the second Ex-Post and Ex-Ante NCA treatments. The change in the preferences was likely due to the experiences workers had during the first treatment.

Table 4. Percentage of Contingency Plans with Preference for Unemployment

(a) Low-Cost Workers

Treatment	Good Signal		Bad Signal	
	First	Second	First	Second
NoNCA	0.0	1.0	5.8	13.5
ExPostNCA	2.0	0.0	20.4	20.2
ExAnteNCA (without NCA)	1.3	0.0	15.2	3.8
ExAnteNCA (with NCA)	3.8	0.0	34.2	31.6

(b) High-Cost Workers

Treatment	Good Signal		Bad Signal	
	First	Second	First	Second
NoNCA	3.4	1.6	33.6	21.0
ExPostNCA	3.6	7.3	25.3	56.1
ExAnteNCA (without NCA)	1.2	18.6	27.9	46.4
ExAnteNCA (with NCA)	2.3	24.7	34.9	53.6

Figure 2 shows the proportion of contingency plans that indicated a preference for unemployment to a position that sent a bad signal. The proportion is shown by job-change cost, treatment order, and whether the average productivity of a worker was above ten sliders per round. More productive workers tended to avoid positions that had a high probability of being a bad match.

IV.C. Unemployment Rate

As a result of the increased willingness to invest, the unemployment rate decreased under the Ex-Post and Ex-Ante NCA treatments during the first treatment as depicted in **Figure 3**. However, the average unemployment rate was higher under the second Ex-Ante NCA treatment than that under the second No-NCA treatment because some high-cost positions were held back by firms. This can be attributed to the net negative return from the first treatment experienced by these firms. The high unemployment rate can also be attributed to the decreased willingness to work among the workers with a high job-change cost.

Figure 2. Preference for Unemployment over Position with a Bad Signal

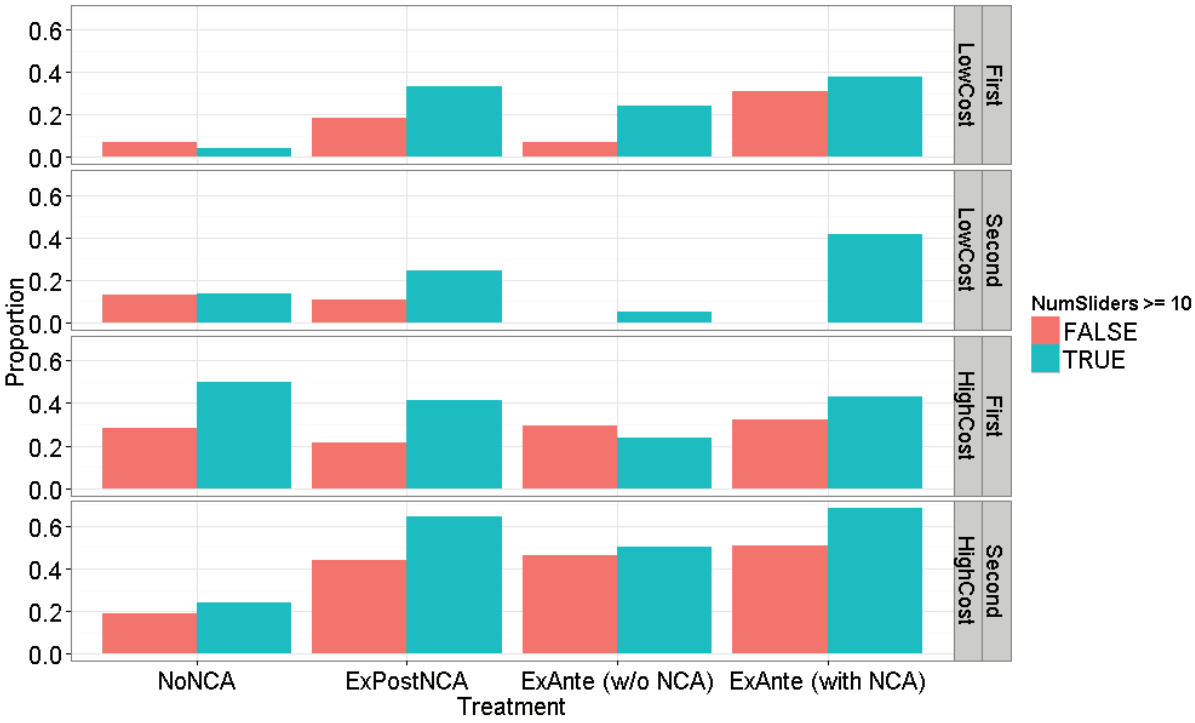
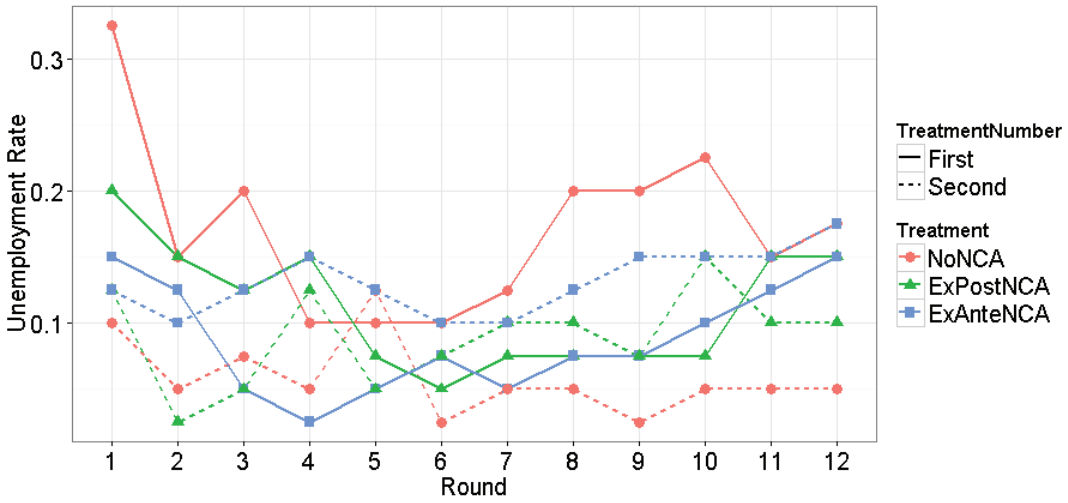


Figure 3. Unemployment Rate by Treatment and Treatment Order



IV.D. NCA Decisions

Table 5 shows the total number of jobs offered in the labor market with and without an NCA along with the proportion of jobs offered with an NCA. For both position types and treatment orders, firms used NCAs less frequently under the Ex-Ante NCA treatment compared to the Ex-Post NCA treatment. The difference in the NCA usage rates between the two treatments was larger for the low-cost positions than for the high-cost positions.

Table 5. Summary of NCA Decisions Made by Firms

(a) Low-Cost Position

Treatment	Treatment Order	Do not impose	Impose NCA	% Impose NCA
Ex-Post NCA	First	35	38	52.05
Ex-Ante NCA	First	45	26	36.62
Ex-Post NCA	Second	35	44	55.70
Ex-Ante NCA	Second	51	21	29.17

(b) High-Cost Position

Treatment	Treatment Order	Do not impose	Impose NCA	% Impose NCA
Ex-Post NCA	First	23	35	60.34
Ex-Ante NCA	First	30	32	51.61
Ex-Post NCA	Second	27	38	58.46
Ex-Ante NCA	Second	25	22	46.81

To test the hypothesis that firms imposed NCAs less frequently under the Ex-Ante NCA treatment than under the Ex-Post NCA treatment, logistic regression models were fitted for the NCA decisions made by firms. **Table 6** shows the estimated coefficients from the logistic regression models for the NCA imposition rates among the low-cost positions. The first Ex-Post NCA treatment was taken to be the baseline case. To control for the potential influence of the first-treatment outcomes on the second-treatment NCA decisions, the points earned by the firms during the first treatment were included in the model. For the first treatment, there was no statistically significant difference in the NCA usage rate. For the second treatment, the odds of imposing an NCA under the Ex-Ante NCA treatment were about 0.4 times the odds under the Ex-Post NCA treatment. The models indicate the odds of imposing an NCA increased about 7% for every 100 points earned during the first treatment. There is no obvious explanation for this difference.

Table 7 shows the estimated coefficients from the logistic regression models for the NCA imposition rates among the high-cost positions. There was no statistically significant difference in the NCA imposition rates between the Ex-Post and Ex-Ante NCA treatments. For every 100 points earned during the first treatment, the odds of imposing an NCA decreased about 6%, while having a net negative points from the first treatment was associated with a three- to six-fold increase in the odds of imposing an NCA.

Table 6. Coefficient Estimates for Logit NCA Decision Models for Low-Cost Positions

Model	(1)	(2)	(3)	(4)
Round Effect	Dummy	Dummy	Quadratic	Quadratic
First Treatment Ex-Ante NCA	–0.692	–0.692	–0.624	–0.624
	(0.443)	(0.443)	(0.423)	(0.423)
Second Treatment	0.248	–1.303	1.210	0.056
	(0.894)	(1.034)	(0.782)	(0.941)
Second Treatment Ex-Ante NCA	–0.925†	–0.828*	–0.944†	–0.843†
	(0.420)	(0.438)	(0.393)	(0.409)
Points from the First Treatment	-	0.076†	-	0.065†
	-	(0.030)	-	(0.027)
Number of observations	295	295	295	295

Shown in the table are the estimated log odds ratios from a logit regression of NCA imposition along with standard errors inside parentheses. The baseline case is the first Ex-Post NCA treatment. The dummy variable for each round were included in model (1) and (2), and the quadratic trend was included in model (3) and (4). The points from the first treatment were divided by 100 to make the interpretation more intuitive. Weights were used equal to the reciprocal of the number of times each firm made the NCA decisions for the low-cost position. The symbols *, †, and ‡ indicates significance at the 10, 5, and 1% level, respectively.

Table 7. Coefficient Estimates for Logit NCA Decision Models for High-Cost Positions

Model	(1)	(2)	(3)	(4)	(5)	(6)
Round Effect	Dummy	Dummy	Dummy	Quadratic	Quadratic	Quadratic
First Treatment Ex-Ante NCA	–0.261	–0.261	–0.261	–0.372	–0.372	–0.372
	(0.477)	(0.477)	(0.477)	(0.441)	(0.441)	(0.441)
Second Treatment	–1.417	–1.226	–1.417	0.069	0.428	–0.035
	(1.383)	(1.397)	(1.383)	(0.922)	(0.989)	(0.927)
Second Treatment Ex-Ante NCA	–0.440	–0.438	–0.688	–0.387	–0.408	–0.599
	(0.526)	(0.544)	(0.575)	(0.473)	(0.491)	(0.528)
Points from the First Treatment	-	–0.055*	-	-	–0.060†	-
	-	(0.032)	-	-	(0.030)	-
Negative Points	-	-	1.888*	-	-	1.243
	-	-	(0.989)	-	-	(0.872)
Number of observations	227	227	227	232	232	232

Shown in the table are the estimated log odds ratios from a logit regression of NCA imposition along with standard errors inside parentheses. The baseline case is the first Ex-Post NCA treatment. The dummy variable for each round were included in model (1)–(3), and the quadratic trend was included in model (4)–(6). Due to perfect collinearity, five observations were dropped from model (1)–(3). The points from the first treatment were divided by 100 to make the interpretation more intuitive. Weights were used equal to the reciprocal of the number of times each firm made the NCA decisions for the high-cost position. The symbols *, †, and ‡ indicates significance at the 10, 5, and 1% level, respectively.

The lower NCA usage rate under the Ex-Ante NCA treatment resulted in the lower NCA prevalence rate. **Table 8** shows the fraction of rounds in which the workers were bound by an NCA. The workers were bound by an NCA less frequently under the Ex-Ante NCA treatment.

Table 8. Proportion of Rounds Workers Were Bound by NCAs

Treatment	Treatment Order	Free of NCA	Bound by NCA	% Bound by NCA
Ex-Post NCA	First	164	262	61.50
Ex-Ante NCA	First	210	228	52.05
Ex-Post NCA	Second	166	271	62.01
Ex-Ante NCA	Second	240	177	42.45

The decisions made by workers also contributed to the lower NCA prevalence rate. **Table 9** shows the percentage of the contingency plans submitted by the workers that indicated the preference for the action in the first column over the action in the second column. Although the primary focus of the workers was to obtain a job that had a higher chance of being a good match, 33% of the contingency plans submitted by the low-cost workers and 45% of the contingency plans submitted by the high-cost workers indicated that the worker preferred unemployment to a job with an NCA that sent a bad signal.

Table 9. Percentages of Contingency Plans with Certain Preferences

Prefers	over	Low Cost	High Cost
Good & No NCA	Good & NCA	84.18	77.60
Bad & No NCA	Bad & NCA	90.51	84.70
Good & NCA	Bad & No NCA	87.34	76.50
Unemployed	Good & NCA	1.90	14.21
Unemployed	Bad & NCA	32.91	44.81

IV.E. Quit Decisions

Thus far, it has been shown that allowing NCAs in the labor market increased investments. The next question is whether NCAs indeed discouraged workers from quitting. In other words, are NCAs effective in mitigating investment risk? **Table 10** shows the total number of stay decisions (i.e., the worker continued the employment with the current employer) and quit decisions (i.e., the worker resigned and sought for a new job) made by workers along with the quit rates. The quit rates tended to be lower among the workers who were bound by an NCA compared to the workers who were free of NCAs.

Another method to measure the effect of NCAs on workers' attitudes toward quitting is to compare the proportions of employment relationships terminated by the quit decisions by the workers. **Table 11** shows the fraction of employments ended by a quit decision by the worker, a fire decision by the firm, and a random termination, conditional on the NCA status. When a firm fired a worker at the same time the worker quit the firm, it was counted as a quit because we are primarily interested in the

effect of NCAs on the quitting decisions of the workers. The low-cost workers were discouraged from quitting when bound by an NCA. An interesting observation is that the firms fired workers less frequently when the workers were bound by an NCA. Because the firms did not know the type of the worker, the effect of NCAs on the fire decisions made by firms should be the same for the low-cost workers and the high-cost workers.

Table 10. Summary of Quit Decisions Made by Workers

(a) Low-Cost Position

Treatment	Treatment Order	Free of NCA			Bound by NCA		
		Stay	Quit	% Quit	Stay	Quit	% Quit
No NCA	First	186	33	15.07	0	0	-
Ex-Post NCA	First	77	14	15.38	114	11	8.80
Ex-Ante NCA	First	112	17	13.18	93	6	6.06
No NCA	Second	192	31	13.90	0	0	-
Ex-Post NCA	Second	75	12	13.79	127	14	9.93
Ex-Ante NCA	Second	127	13	9.29	86	2	2.27

(b) High-Cost Position

Treatment	Treatment Order	Free of NCA			Bound by NCA		
		Stay	Quit	% Quit	Stay	Quit	% Quit
No NCA	First	170	9	5.03	0	0	-
Ex-Post NCA	First	68	5	6.85	130	7	5.11
Ex-Ante NCA	First	71	10	12.35	123	6	4.65
No NCA	Second	222	7	3.06	0	0	-
Ex-Post NCA	Second	75	4	5.06	122	8	6.15
Ex-Ante NCA	Second	92	8	8.00	86	3	3.37

Table 11. Termination Type by NCA Status

Worker Type	NCA Status	Quit	Fire	Random
Low Cost	Free of NCA	0.48	0.25	0.27
	Bound by NCA	0.36	0.13	0.51
High Cost	Free of NCA	0.28	0.37	0.34
	Bound by NCA	0.32	0.26	0.42

To test the hypothesis that NCAs discouraged workers from quitting, logit regression models were fitted for the quit decisions made by workers. The first No-NCA treatment was taken to be the baseline case. The estimates were controlled for workers' beliefs regarding match quality. **Table 12** shows the coefficient estimates from the logit models of quit rates for the low-cost workers. The odds of quitting when the workers were bound by an NCA were about 0.40–0.45 times the odds when the workers were not bound by an NCA. The effect of the NCA treatment on the quit rate was insignificant after controlling for the NCA status and the posterior probability of being in a bad match given the signals worker received.

Table 12. Coefficient Estimates for Logit Quit Decision Models for Low-Cost Workers

Model	(1)	(2)	(3)	(4)
Round Effect	Dummy	Dummy	Quadratic	Quadratic
Bound by NCA	–0.817‡	–0.927‡	–0.800‡	–0.902‡
	(0.260)	(0.263)	(0.261)	(0.264)
P(bad match)	-	0.028‡	-	0.027‡
	-	(0.003)	-	(0.003)
P(bad match) ≥ 80%	2.117‡	-	2.079‡	-
	(0.245)	-	(0.242)	-
P(bad match) ≥ 90%	0.192	-	0.261	-
	(0.272)	-	(0.259)	-
P(bad match) ≥ 95%	–1.001†	-	–1.051‡	-
	(0.409)	-	(0.406)	-
First Treatment Ex-Post NCA	0.078	0.077	0.080	0.063
	(0.340)	(0.341)	(0.348)	(0.347)
First Treatment Ex-Ante NCA	–0.220	–0.369	–0.207	–0.355
	(0.330)	(0.329)	(0.326)	(0.326)
Second Treatment	–0.288	–0.351	–0.282	–0.348
	(0.297)	(0.290)	(0.296)	(0.289)
Second Treatment Ex-Post NCA	0.398	0.469	0.366	0.446
	(0.336)	(0.331)	(0.331)	(0.326)
Second Treatment Ex-Ante NCA	–0.563	–0.486	–0.579	–0.495
	(0.362)	(0.356)	(0.363)	(0.357)
Number of observations	1231	1231	1342	1342

Shown in the table are the estimated log odds ratios from a logit regression of quitting along with standard errors inside parentheses. The baseline case is the first NCA treatment. The dummy variable for each round were included in model (1) and (2), and the quadratic trend was included in model (3) and (4). Due to perfect collinearity, 111 observations were dropped from model (1) and (2). Weights were used equal to the reciprocal of the number of times each worker made the quit decisions. The posterior probability of being in a bad match was calculated based on the signals workers received. The symbols *, †, and ‡ indicates significance at the 10, 5, and 1% level, respectively.

Table 13 shows the coefficient estimates from the logit models of quit rates for the high-cost workers. Neither the profit from the first treatment nor the negative-profit dummy variable significantly changed the coefficient estimates, and therefore was omitted from the model. The effect of an NCA on a worker's quitting decision was not as strong as that for the low-cost workers: the odds ratio of quitting when bound by an NCA to when not bound by an NCA for the high-cost workers was about 0.56.

Table 13. Coefficient Estimates for Logit Quit Decision Models for High-Cost Workers

Model	(1)	(2)	(3)	(4)
Round Effect	Dummy	Dummy	Quadratic	Quadratic
Bound by NCA	–0.578 *	–0.582 *	–0.587 *	–0.594 *
	(0.335)	(0.335)	(0.330)	(0.332)
P(bad match)	-	0.027 ‡	-	0.027 ‡
	-	(0.005)	-	(0.005)
P(bad match) ≥ 80%	1.807 ‡	-	1.824 ‡	-
	(0.411)	-	(0.409)	-
P(bad match) ≥ 90%	0.011	-	–0.034	-
	(0.408)	-	(0.377)	-
P(bad match) ≥ 95%	0.046	-	0.073	-
	(0.461)	-	(0.461)	-
First Treatment Ex-Post NCA	0.430	0.440	0.439	0.475
	(0.489)	(0.494)	(0.508)	(0.511)
First Treatment Ex-Ante NCA	1.104 †	1.133 †	1.087 †	1.142 †
	(0.508)	(0.514)	(0.524)	(0.532)
Second Treatment	–0.424	–0.432	–0.408	–0.415
	(0.536)	(0.535)	(0.546)	(0.545)
Second Treatment Ex-Post NCA	0.895 *	0.882	0.881	0.858
	(0.540)	(0.545)	(0.536)	(0.537)
Second Treatment Ex-Ante NCA	0.799	0.798	0.802	0.808
	(0.550)	(0.551)	(0.549)	(0.547)
Number of observations	1129	1129	1226	1226

Shown in the table are the estimated log odds ratios from a logit regression of quitting along with standard errors inside parentheses. The baseline case is the first NCA treatment. The dummy variable for each round were included in model (1) and (2), and the quadratic trend was included in model (3) and (4). Due to perfect collinearity, 97 observations were dropped from model (1) and (2). Weights were used equal to the reciprocal of the number of times each worker made the quit decisions. The posterior probability of being in a bad match was calculated based on the signals workers received. The symbols *, †, and ‡ indicates significance at the 10, 5, and 1% level, respectively.

One unexpected result was that the odds of quitting for the first Ex-Ante NCA treatment were about three times the odds for the first No-NCA treatment. Furthermore, all models indicate the workers were more willing to quit under the Ex-Post and Ex-Ante NCA treatments during both the first and the second treatment, after controlling for the NCA status and the posterior probability of being in a bad

match. It is possible that the workers were more optimistic about quitting because the *expected* unemployment rate was lower under these treatments. It is also possible that NCAs somehow helped workers justify quitting: when not bound by an NCA, workers assumed their employer was a low-cost type, and felt less guilty about quitting; when bound by an NCA, workers retaliated to their employers by quitting and forcing the employer to pay the transaction costs at their own expense. However, these are unsupported explanations, and the true reasons the workers quit are unknown.

IV.F. Labor Mobility Rate

As a result of the lower quit rate when bound by an NCA, the labor mobility rate decreased under the Ex-Post and Ex-Ante NCA treatments. **Table 14** shows the average number of jobs held by workers over the twelve rounds and the average length of jobs. Workers tended to change jobs more frequently under the No-NCA treatment, especially during the first treatment.

Table 14. Average Number of Jobs and Average Job Spell

Treatment	Treatment Order	Average Number of Jobs	Average Job Length
No NCA	First	2.48	2.82
Ex-Post NCA	First	2.22	3.35
Ex-Ante NCA	First	2.21	3.56
No NCA	Second	2.23	3.48
Ex-Post NCA	Second	2.18	3.55
Ex-Ante NCA	Second	2.13	3.69

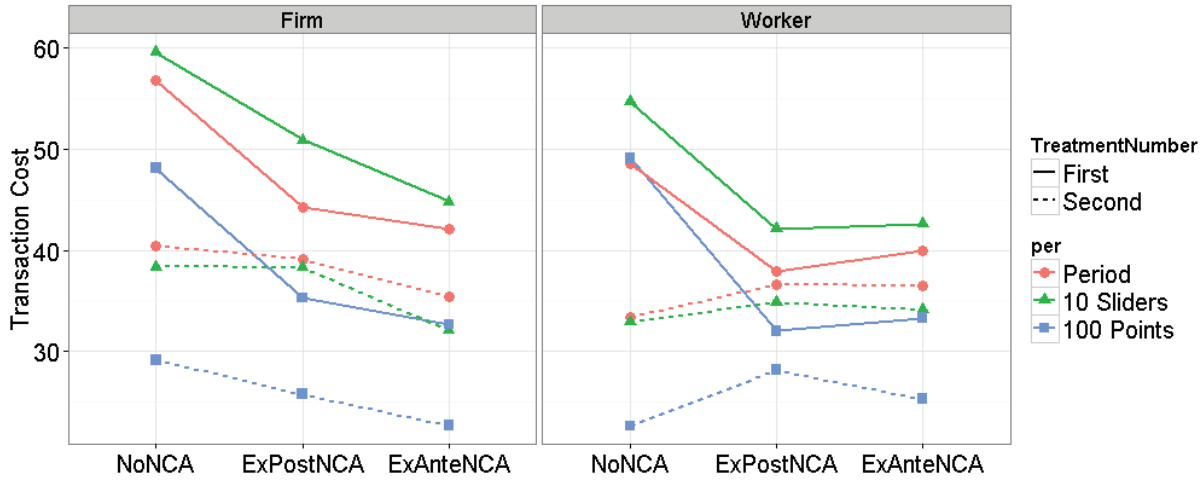
IV.G. Transaction Costs

As a consequence of the reduced labor mobility rate, the transaction costs incurred by firms and workers decreased. **Figure 4** shows the transaction cost per period employed, per number of sliders, and per points earned. Since the transaction costs for the low-cost positions and low-cost workers were small compared to the revenue, only high-cost positions and high-cost workers are included in the graph. All three measures indicate that NCA reduced the per-profit hiring cost for the high-cost positions. The difference in the transaction costs among treatments was larger for the first treatment. During the first treatment, the job-change costs incurred by the high-cost workers were significantly lower for the Ex-Post and Ex-Ante treatments, partly due to the lower rate of firing by firms. The approximate *p*-values from Wilcoxon rank-sum tests are summarized in **Table 15**.

Table 15. *p*-values from Wilcoxon Rank-Sum Test on Differences in Transaction Costs

Agent	Hypothesis	Period	10 Sliders	100 Points
Firm	No NCA > Ex-Post NCA	0.076	0.146	0.067
Firm	No NCA > Ex-Ante NCA	0.035	0.067	0.033
Worker	No NCA > Ex-Post NCA	0.059	0.088	0.074
Worker	No NCA > Ex-Ante NCA	0.130	0.087	0.057

Figure 4. Transaction Cost per Revenue by Treatment

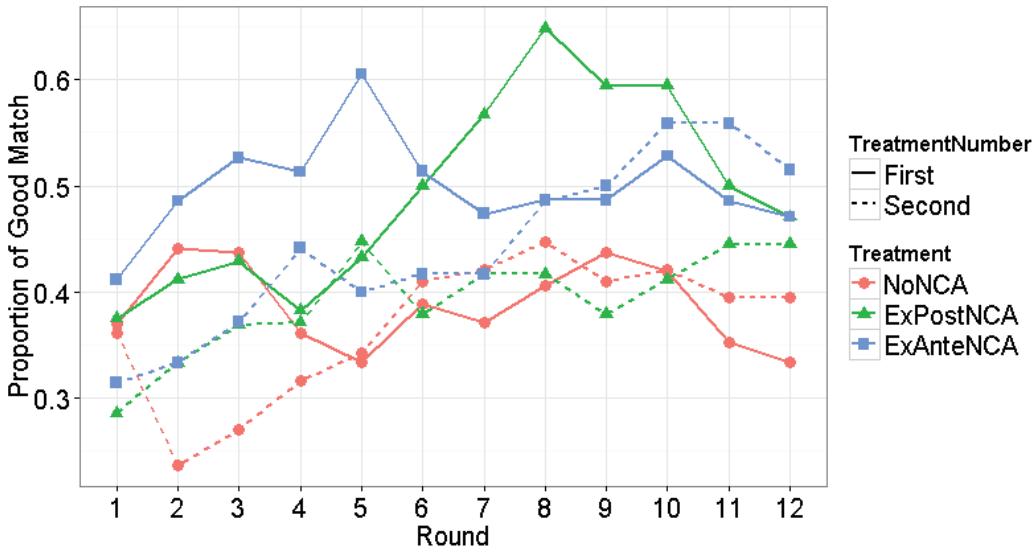


IV.H. Match Quality

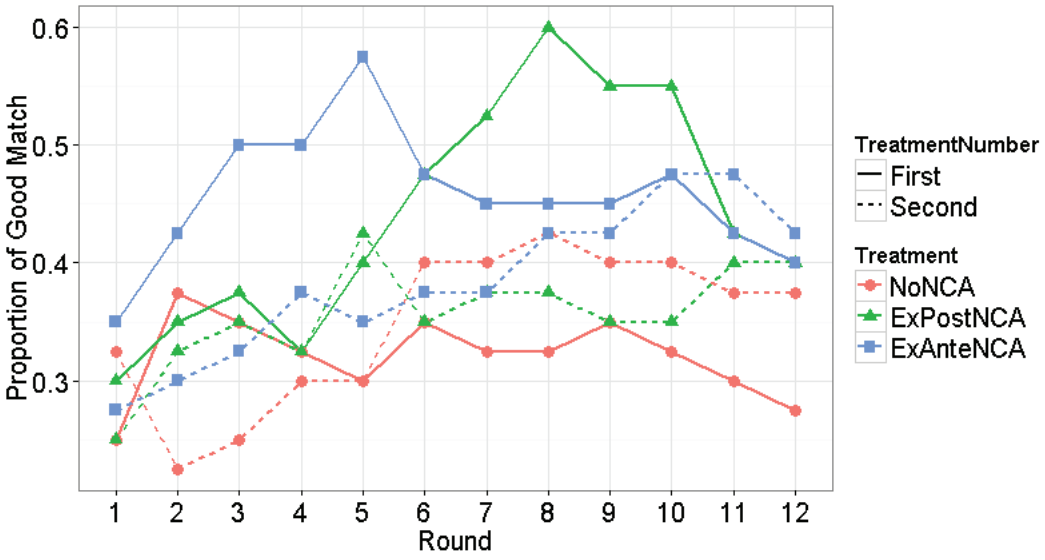
Although the reduced labor mobility decreased the transaction costs, its effect on the match quality is unclear. **Figure 5** illustrates the change in the proportion of good matches over the twelve rounds. Shown in Figure 5(a) is the proportion of good matches among all matches in each round. Shown in Figure 5(b) is the proportion of good matches among actual and potential matches. In Figure 5(b), unmatched pairs were counted as a bad match. Despite the highest mobility rate, the first No-NCA treatment failed to improve the match quality. The trend of the overall match quality was similar among treatments for the second treatment.

Figure 5. Change in Proportion of Good Matches over Rounds

(a) Proportion of Good Matches (Unmatched Pairs Excluded)



(b) Proportion of Good Matches (Unmatched Pairs Counted Toward Bad Match)



To identify the possible causes for the lack of the improvement in the match quality, the quit, fire, and random termination rates are summarized in **Table 16**. An unusually high fire rate under the first No-NCA treatment could be a contributing factor for the stalled match quality.

Table 16. Possible Factors for Difference in Match Quality

Treatment	Treatment Order	% Quit		% Fire		% Random Termination	
		Bad Match	Good Match	Bad Match	Good Match	Bad Match	Good Match
No NCA	First	15.6	2.6	15.6	4.5	6.6	11.0
Ex-Post NCA	First	14.0	3.3	12.1	1.9	8.4	10.4
Ex-Ante NCA	First	14.6	3.2	9.6	2.3	5.0	9.1
No NCA	Second	13.0	0.6	9.5	2.4	5.6	7.8
Ex-Post NCA	Second	12.0	3.5	8.6	1.8	7.9	5.8
Ex-Ante NCA	Second	9.9	1.6	11.6	1.1	8.2	8.7

To test the veracity of the earlier finding that the firms were more reluctant to fire workers bound by an NCA, logistic regression models were fitted for the fire rate. The first No-NCA treatment was taken to be the baseline case. The estimates were controlled for the posterior probability of being in a bad match. The coefficient estimates are shown in **Table 17** for the low-cost positions and in **Table 18** for the high-cost positions. For the low-cost positions, the odds of firing when the firm imposed an NCA on the worker were about 0.42–0.49 times the odds of firing when the firm did not impose an NCA. For the

high-cost positions, the odds of firing a worker when the firm imposed an NCA were about a third the odds of firing when the firm did not impose an NCA.

Table 17. Coefficient Estimates for Logit Fire Decision Models for Low-Cost Positions

Model	(1)	(2)	(3)	(4)
Round Effect	Dummy	Dummy	Quadratic	Quadratic
Imposed NCA	–0.804†	–0.857‡	–0.718†	–0.781‡
	(0.324)	(0.311)	(0.308)	(0.301)
Number of Sliders	–0.358‡	–0.363‡	–0.327‡	–0.339‡
	(0.051)	(0.051)	(0.049)	(0.048)
P(bad match)	-	0.023‡	-	0.023‡
	-	(0.003)	-	(0.003)
P(bad match) >= 80	2.387‡	-	2.228‡	-
	(0.260)	-	(0.258)	-
P(bad match) >= 90	–1.625‡	-	–1.421‡	-
	(0.434)	-	(0.412)	-
P(bad match) >= 95	0.539	-	0.421	-
	(0.534)	-	(0.512)	-
First Treatment Ex-Post NCA	–0.237	–0.257	–0.257	–0.269
	(0.383)	(0.363)	(0.373)	(0.359)
First Treatment Ex-Ante NCA	–0.718*	–0.668	–0.685	–0.645
	(0.429)	(0.414)	(0.422)	(0.408)
Second Treatment	0.302	0.312	0.326	0.310
	(0.328)	(0.320)	(0.326)	(0.320)
Second Treatment Ex-Post NCA	0.297	0.294	0.172	0.222
	(0.403)	(0.392)	(0.380)	(0.377)
Second Treatment Ex-Ante NCA	–0.185	–0.105	–0.216	–0.133
	(0.368)	(0.357)	(0.361)	(0.355)
Number of observations	1295	1295	1414	1414

Shown in the table are the estimated log odds ratios from a logit regression of firing along with standard errors inside parentheses. The baseline case is the first NCA treatment. The dummy variable for each round were included in model (1) and (2), and the quadratic trend was included in model (3) and (4). Due to perfect collinearity, 119 observations were dropped from model (1) and (2). Weights were used equal to the reciprocal of the number of times each firm made the fire decisions for the low-cost position. The posterior probability of being in a bad match was calculated based on the signals firms received. The symbols *, †, and ‡ indicates significance at the 10, 5, and 1% level, respectively.

Table 18. Coefficient Estimates for Logit Fire Decision Models for High-Cost Positions

Model	(1)	(2)	(3)	(4)
Round Effect	Dummy	Dummy	Quadratic	Quadratic
Imposed NCA	–1.170‡	–1.237‡	–1.141‡	–1.216‡
	(0.368)	(0.377)	(0.368)	(0.381)
Number of Sliders	–0.145†	–0.150†	–0.141†	–0.145†
	(0.067)	(0.070)	(0.065)	(0.067)
P(bad match)	-	0.019‡	-	0.018‡
	-	(0.005)	-	(0.005)
P(bad match) >= 80	1.927‡	-	1.843‡	-
	(0.390)	-	(0.409)	-
P(bad match) >= 90	–1.031†	-	–0.841*	-
	(0.518)	-	(0.477)	-
P(bad match) >= 95	0.310	-	0.112	-
	(0.651)	-	(0.579)	-
First Treatment Ex-Post NCA	–0.190	–0.057	–0.173	–0.047
	(0.506)	(0.488)	(0.471)	(0.467)
First Treatment Ex-Ante NCA	0.046	–0.003	–0.046	–0.026
	(0.485)	(0.500)	(0.477)	(0.495)
Second Treatment	–2.001‡	–2.112‡	–2.019‡	–2.095‡
	(0.630)	(0.624)	(0.626)	(0.621)
Second Treatment Ex-Post NCA	0.923	1.024	0.981	1.018
	(0.713)	(0.702)	(0.699)	(0.695)
Second Treatment Ex-Ante NCA	2.263‡	2.293‡	2.221‡	2.275‡
	(0.678)	(0.686)	(0.684)	(0.691)
Number of observations	1065	1065	1154	1154

Shown in the table are the estimated log odds ratios from a logit regression of firing along with standard errors inside parentheses. The baseline case is the first NCA treatment. The dummy variable for each round were included in model (1) and (2), and the quadratic trend was included in model (3) and (4). Due to perfect collinearity, 89 observations were dropped from model (1) and (2). Weights were used equal to the reciprocal of the number of times each firm made the fire decisions for the high-cost position. The posterior probability of being in a bad match was calculated based on the signals firms received. The symbols *, †, and ‡ indicates significance at the 10, 5, and 1% level, respectively.

Three possible explanations exist for the lower odds of firing in the case of firms that imposed an NCA. The first is based on selection bias: risk-averse firms imposed NCAs and refrained from firing workers because doing so involved greater risk. The second is based on ethical reasons: the firms possibly felt empathetic towards workers. The final reason is based on concerns for the small labor market: firms were afraid of firing and subsequently re-hiring the same worker or, even worse, being unable to fill the position. Because there were just enough workers to fill the positions, executing an NCA could backfire on the firm. If the firms were discouraged from firing for strategic reasons, the effects of NCAs on the fire decisions would dissipate in the real labor market because the market is larger and has more workers.

However, if the firms refrained from firing the workers for ethical reasons, the results may hold in the real world.

IV.I. Productivity

The analyses presented in the previous sections provided some evidence that NCAs were effective in encouraging firms to invest in their employees and discouraging workers from quitting. However, NCAs can lower the morale of workers and lead to reduced productivity. To test the hypothesis that workers' productivity is influenced by the NCA status, linear regression models were fitted for the number of slider tasks completed in each round. The coefficients estimates from the models are shown in **Table 19**. The control variables include worker effects and the interaction of the round, treatment number, and server to accommodate for the differences in the learning curves between the sessions conducted on the slow server and the fast server.

Table 19. Coefficient Estimates for Linear Regression Model for Number of Sliders

Model	(1)	(2)	(3)	(4)
Round Effect	Dummy	Dummy	Quadratic	Quadratic
Bound by NCA	–0.222†	-	–0.216†	-
	(0.098)	-	(0.100)	-
Bound by NCA Ex-Post NCA	-	–0.195	-	–0.164
	-	(0.140)	-	(0.142)
Bound by NCA Ex-Ante NCA	-	–0.248*	-	–0.268*
	-	(0.140)	-	(0.142)
First Treatment Ex-Post NCA	0.209	0.191	–0.314*	–0.348†
	(0.178)	(0.190)	(0.172)	(0.184)
First Treatment Ex-Ante NCA	–0.083	–0.072	–0.563‡	–0.540‡
	(0.177)	(0.182)	(0.170)	(0.175)
Second Treatment Ex-Post NCA	0.402†	0.387†	0.959‡	0.929‡
	(0.181)	(0.189)	(0.175)	(0.184)
Second Treatment Ex-Ante NCA	0.830‡	0.841‡	1.362‡	1.383‡
	(0.172)	(0.176)	(0.166)	(0.171)
High Piece Rate	0.121*	0.121*	0.143†	0.143†
	(0.072)	(0.072)	(0.073)	(0.073)
Number of observations	2568	2568	2568	2568

Shown in the table are the estimated changes in the number of slider tasks completed by workers from a linear regression along with standard errors inside parentheses. The baseline case is the first NCA treatment. Worker effects were included in the model but the estimates are not shown here. The dummy variable for each round were included in model (1) and (2), and the quadratic trend was included in model (3) and (4). The round effects were estimated for the slow server and the fast server separately. The symbols *, †, and ‡ indicates significance at the 10, 5, and 1% level, respectively.

In general, being bound by an NCA decreased worker productivity. The negative effect of NCAs on worker productivity was greater for the Ex-Ante NCA treatment than the Ex-Post NCA treatment. The effects of the NCA policy on the worker productivity after controlling for the NCA status and the piece rate were somewhat mixed. According to model (3) and (4), where the quadratic round trend was included, the workers completed fewer slider tasks during the first treatment under the Ex-Post and Ex-Ante NCA treatments than under the No-NCA treatment. A possible explanation is that less productive workers were hired under the Ex-Post and Ex-Ante NCA treatments due to the increased willingness to invest. During the second treatment, the workers completed more slider tasks under the Ex-Post and Ex-Ante NCA treatment than under the No-NCA treatment. This could be attributed to less productive workers being unemployed due to the higher unemployment rates. It could also be due to the externalities caused by the NCA policy: workers exerted more effort in the slider tasks even when they were not bound by an NCA because there was a possibility that the next employer would impose an NCA.

IV.J. Social Surplus

Finally, the average worker, firm, and social surplus are shown in **Table 20**. The social surplus should reflect the outcomes of the following four factors: unemployment rate, transaction costs, match quality, and worker productivity.

During the first treatment, the social surplus was 10% higher under the Ex-Post NCA treatment and 22% higher under the Ex-Ante NCA treatment compared to that under the No-NCA treatment. This was expected because under the Ex-Post and Ex-Ante NCA treatments, the unemployment rate was lower, the transaction costs were less, and the match quality was better.

During the second treatment, the social surplus under the Ex-Post and Ex-Ante NCA treatments were 5% and 3% less, respectively, compared to that under the No-NCA treatment. This is probably due to increased hold-backs of high-cost positions during the second treatment under the Ex-Post and Ex-Ante NCA treatments. None of the differences is statistically significant partly due to a small sample size (n = 30).

Table 20. Relative Economic Surplus (No NCA = 100)

Treatment	Treatment Order	Worker	Firm	Total
Ex-Post NCA	First	118	101	110
Ex-Ante NCA	First	130	113	122
Ex-Post NCA	Second	103	88	95
Ex-Ante NCA	Second	102	92	97

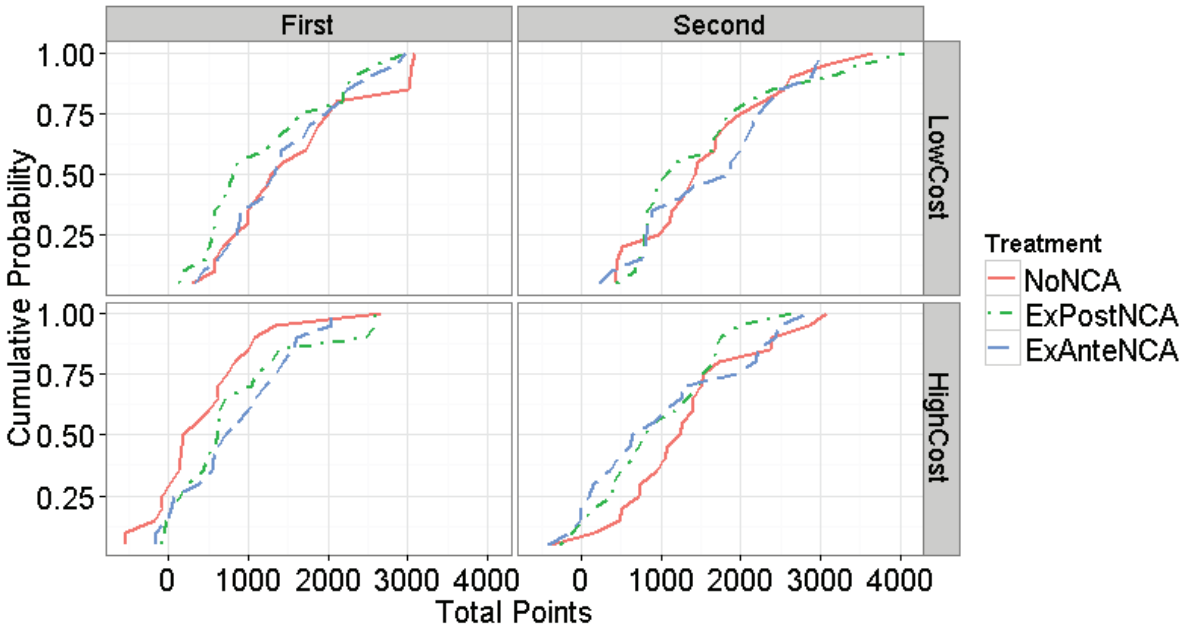
IV.K. Worker Surplus

To analyze how workers managed to increase the surplus under the Ex-Post and Ex-Ante NCA treatments (where they were expected to suffer from reduced labor mobility), worker surplus was further separated into surplus from the low-cost workers and high-cost workers. **Figure 6** shows the cumulative density functions for the net points earned by workers. In general, the high-cost workers were worse off than low-cost workers.

During the first treatment, the low-cost workers were better off under the No-NCA treatment than under the Ex-Post NCA treatment (Kolmogorov-Smirnov test approximate p-value = 0.165; Wilcoxon rank-sum test approximate p-value = 0.063). The lower return under the Ex-Post NCA treatment can be partially explained by the lower piece rate as a result of being bound by an NCA.

The relationship was reversed for the high-cost positions: workers were better off under the Ex-Post NCA treatment than under the No-NCA treatment (Kolmogorov-Smirnov test approximate p-value = 0.287; Wilcoxon rank-sum test approximate p-value = 0.065). The difference between the Ex-Ante NCA treatment and the No-NCA treatment for the high-cost positions during the first treatment was also statistically significant (Kolmogorov-Smirnov test approximate p-value = 0.165; Wilcoxon rank-sum test approximate p-value = 0.065). The higher economic returns for the high-cost workers under the Ex-Post and Ex-Ante NCA treatments can be attributed to the firm's reluctance to fire a worker on whom the firm imposed an NCA.

Figure 6. Cumulative Density Functions of Worker Surplus

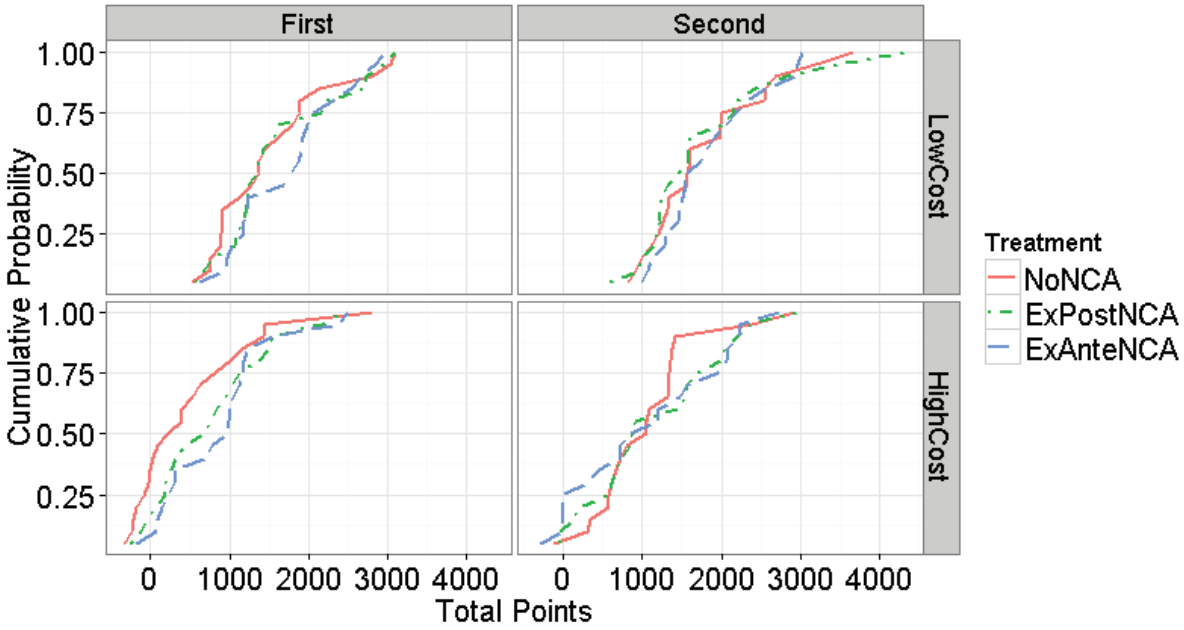


IV.L. Firm Surplus

The firm surplus was also separated into surplus from the low-cost positions and high-cost positions. **Figure 7** shows the cumulative density functions for the net points earned by firms. During the first treatment, the high-cost positions earned more points under the Ex-Ante NCA treatment than under the No-NCA treatment (Kolmogorov-Smirnov test approximate p-value = 0.086; Wilcoxon rank-sum test approximate p-value = 0.028).

The subjects who held back the high-cost positions under the second Ex-Ante NCA treatment were observed to be concentrated at 0 points. There is some evidence that during the second treatment, the high-cost positions earned more points under the Ex-Post NCA treatment than under the No-NCA treatment (Kolmogorov-Smirnov test approximate p-value = 0.086; Wilcoxon rank-sum test approximate p-value = 0.299). However, the results from the second treatment should be interpreted with care because investment and NCA decisions were heavily influenced by the outcomes of the first treatment.

Figure 7. Cumulative Density Functions of Firm Surplus



V. Summary

To study the impact of NCA policies on the decisions made by workers and firms in the labor market, a laboratory experiment was conducted. The economic outcomes were compared under three NCA treatments: No-NCA treatment, under which the implementation of an NCA was prohibited; Ex-Post NCA treatment, under which firms imposed NCAs after workers accepted a job offer; and Ex-Ante NCA treatment, under which firms were required to inform the workers of the NCA requirements in the job offer.

When firms were allowed to impose NCAs, they were more willing to hire workers for high-cost positions. However, the hiring decisions were heavily influenced by the past experiences of the firms: the

firms that had a net negative economic return from the first treatment had approximately one third the odds of hiring a worker compared to the firms that had a net positive economic return. The odds of NCA usage during the second treatment for the low-cost positions under the Ex-Ante NCA treatment were about 0.4 times the odds under the Ex-Post NCA treatment. Decisions to impose an NCA were also influenced by the points earned during the first treatment: the odds of imposing an NCA for the firms that had a net negative economic return from the high-cost position during the first treatment were 3 to 6 times the odds for the firms that had a net positive economic return.

As a result of the lower NCA usage rate, the fraction of rounds in which the workers were bound by an NCA was smaller under the Ex-Ante NCA treatment than under the Ex-Post NCA treatment. Under the Ex-Ante NCA treatment, the decisions made by the workers also contributed to the lower prevalence rate of NCAs; about 33% of the contingency plans submitted by the low-cost workers and about 45% of the contingency plans submitted by the high-cost workers indicated a preference for unemployment over a job with an NCA that the signal indicated a high probability of a bad match. When bound by an NCA, the odds of quitting decreased by 55–60% for the low-cost workers and by about 44% for the high-cost workers. The average number of jobs held by workers was smaller and the average length of jobs was longer under the treatments that allowed implementation of NCAs.

Decreased labor mobility resulted in a reduction in the transaction costs under the Ex-Post and Ex-Ante NCA treatments. Furthermore, regarding the match quality, the Ex-Post and Ex-Ante NCA treatments fared better than the No-NCA treatment despite decreased labor mobility. One possible reason is the reluctance of firms in firing workers who were bound by an NCA. For the low-cost positions, the odds of firing a worker when the firm imposed an NCA were 0.42–0.49 times the odds of firing when the firm did not impose an NCA. For the high-cost positions, the odds ratio was about one third.

There was some evidence that being bound by an NCA decreased productivity of the workers, but the magnitude of the effect was small. For the first treatment, the average social surplus was 10% more for the Ex-Post NCA treatment and 22% more for the Ex-Ante NCA treatment than that for the No-NCA treatment. For the second treatment, the average social surplus was 5% and 3% smaller for the Ex-Post and Ex-Ante NCA treatment, respectively, than that for the No-NCA treatment due to increased unemployment: firms that had a net negative economic return during the first treatment tended to hold back the high-cost positions during the second treatment.

The welfare of the workers and the firms were affected by the NCA policy as follows. During the first treatment, the low-cost workers fared better under the No-NCA treatment, while the high-cost workers fared better under the Ex-Post and Ex-Ante NCA treatments. The smaller surplus experienced by the low-cost workers under the pro-NCA policies can be explained by the decreased piece rates as a result of the execution of NCAs. The larger surplus experienced by the high-cost workers under the pro-NCA policies can be explained by the reluctance of firms to fire workers bound by an NCA. The firms fared better under the Ex-Post and Ex-Ante NCA treatments than under the No-NCA treatments thanks to the protection against their investments and reduced transaction costs.

As demonstrated in this study, the burden of monitoring unfair usage of NCAs can be transferred from states to workers. Mandatory ex-ante disclosure of NCA requirements also provides workers and firms with the opportunities to work together to establish the terms of employment contracts that maximize the total economic return. However, whether a market can reach the optimal level of NCA usage is ultimately determined by the balance in bargaining power between workers and firms. The clause on the timing of NCA requests is only a small fraction of the state statutes regarding NCA enforceability,

but it can have a significant impact on the relative bargaining power between workers and firms, and in the long run, on the overall economy of the state.

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Appendix A: Instruction for No-NCA Treatment

Instruction

At the end of this instruction, you will have a quiz. For each correctly answered question, you will earn 10 cents.

In this experiment, you will make a series of decisions regarding forming and dissolving employment relationships. Some participants will be assigned a role of a **worker** and others will be assigned a role of a **firm**. Your role remains fixed throughout the experiment. If you are a worker, you will be asked to perform slider tasks, which will be explained later. If you are a firm, you will make hiring and firing decisions. There will be **two (2) sessions** in this experiment, and each session consists of 12 periods.

In each period, the following sequence of events occurs:

(1) Unemployed workers and firms with available position(s)/job(s) are given a chance to **form employment relationships**.
(2) Employed workers **perform slider tasks**, and workers and firms earn points according to the performance of the workers.
(3) Workers and firms are given an opportunity to **dissolve employment relationships**.

Compensation:
Of the two sessions in this experiment, only one of them will be used to calculate your payment. At the end of the experiment, one session is randomly chosen to calculate your payment. Both sessions are equally likely to be selected. If you are a worker, you will be paid **$1.00 for every 100 points** you earned. If you are a firm, you will be paid **$1.00 for every 200 points** you earned. Your earning will be rounded to the nearest dollar.

Setup:
There will be **8 workers** and **4 firms**. Each firm has two positions. In each period, a worker can take at most one position, and a position can be filled by at most one worker. Thus, it is possible that every worker is employed and every position is filled.

Half of the workers (that is, 4 workers) have a job-change cost of **20 points**, while the remaining half has a job-change cost of **150 points**. Whenever a worker takes a new position, the worker pays the job-change cost. If a worker has not earned enough points to cover the job-change cost at the time of matching, the worker can still take a new position, but his or her cumulative point earning will be temporarily negative. For example, if a worker with a job-change cost of 20 points takes a position in period 1, the worker's cumulative point earning right after matching and before the slider task will be –20.

Each firm has one **Position A**, which incurs a hiring cost of **20 points**, and one **Position B**, which incurs a hiring cost of **150 points**. Whenever a firm hires a new worker for a position, the firm pays the respective hiring cost. The hiring costs incurred by firms and the job-change costs incurred by workers are completely separate and independent of each other. Firms' cumulative point earning can also go negative;

firms need not have enough point earning to cover the hiring cost at the time of matching, but they have to "pay back" the point debts later. A firm may hire any unemployed worker to fill any position.

Match Quality:

At the beginning of each matching sequence, a computer will assign "**good match**" or "**bad match**" to each of all possible pairs of an available worker and an unfilled position. **The probability of realizing a good match is 20%**. A position can be a good match for one worker, but it may be a bad match for another worker. The true quality of match is unknown to workers and firms; however, each worker receives a signal from each position that reveals some information about the true match quality:

- If the position is a good match, on average, there are **4 good signals for every 1 bad signal**.
- If the position is a bad match, on average, there is **1 good signal for every 4 bad signals**.

Note that receiving a good signal does not guarantee an underlying good match.

These signals also set the piece rate for the slider tasks that follow:

- **25 points** per completed slider task for a good signal.
- **5 points** per completed slider task for a bad signal.

The match quality remains the same throughout each employment relationship. However, once the relationship has ended, a new match quality is assigned for the next job, which may or may not be the same as the previous match quality.

1. Forming Employment Relationships

Firm's Decision:
At the beginning of a period, each firm decides whether or not to offer each unfilled position in the labor market. Note that firms cannot offer positions that are already filled.

Worker's Decision:
Unemployed workers will be asked to rank the following actions according to their preferences:

- Take a position with a good signal;
- Take a position with a bad signal; or
- Remain unemployed.

Matching Algorithm:
After all firms with open positions and unemployed workers submit their decisions, the computer will match positions and workers according to the following algorithm.

First, all unemployed workers are sorted according to the number of sliders completed in the most recent period in which the worker was employed. The initial matching at the beginning of the session will be based on the number of sliders completed during the trial period. Ties are broken by flipping a coin (done by a computer).

Workers, from the top of the queue, i.e. those who completed the most sliders in the previous period, are assigned positions that best match their preferences, or remain unemployed if no available position satisfies their preferences. If there are more than one positions with the same characteristics of worker's choice, the computer will randomly choose one. The selected position and the worker are matched. That position becomes unavailable to other workers. The computer chooses a position for the next worker in the queue from the remaining positions. This process continues until there is no position available or all workers are given an opportunity to choose a position. This matching process is automated by the computer.

Illustrative example:
Suppose there are three unemployed workers (worker 1, worker 2, and worker 3) and two positions submitted in the labor market (position C and position D) with the following characteristics.

	worker 1	**worker 2**	**worker 3**
Number of sliders	10	12	9
Signal from position C	Good	Good	Bad
Signal from position D	Bad	Good	Bad
Preference 1	Good signal	Good signal	Good signal
Preference 2	Unemployed	Bad signal	Bad signal
Preference 3	Bad signal	Unemployed	Unemployed

The worker queue looks like worker 2 – worker 1 – worker 3 because worker 2 completed the most sliders and worker 3 the least.

Worker 2's first preference is a good signal, and there are two positions available with a good signal. Suppose the computer randomly chose position C for worker 2.

Now, we continue on to worker 1. Worker 1's first preference is a good signal, but no position with a good signal is available because position C is already taken by worker 2. Worker 1's second preference is to remain unemployed, so he or she remains unemployed.

We continue on to worker 3. Worker 3's first preference is good signal, but no position with a good signal is available. Worker 3's second preference is a bad signal, and position D has a bad signal. Thus, worker 3 chooses position D.

The final assignment is as follows: worker 1 is unemployed, worker 2 takes position C, and worker 3 takes position D.

2. Slider Task

After the matching of workers and positions has occurred, employed workers will perform slider tasks. Workers will move sliders to the target positions using a mouse and a keyboard.

You will see an example of slider tasks on your screen in a moment.

Now, we will begin a tutorial session. The performance during the tutorial does not affect your payment.

There are 20 sliders in total. The goal is to complete as many slider tasks as possible within 45 seconds. On the top right corner, you will see the remaining time. On the second row, you see the piece rate for the period. The piece rate is 0 during the tutorial because you do not earn any points for completing sliders during the tutorial, but it will be either 5 points or 25 points during the actual periods.

The target position for the slider is indicated on the left to the bar. The current position is indicated on the right to the bar. The left end represents position 0 and the right end represents position 100. Try dragging and dropping the first slider to its target position. When you are done, try completing a couple more sliders by dragging and dropping. If you have difficulty with moving sliders, please raise your hand, and I will assist you.

There are some techniques you can use in addition to dragging and dropping:

- Clicking a point on the bar to the right [left] of the slider moves the slider to the right [left] by 21.
- The middle scroll wheel on the mouse moves the slider but does not update the current slider position.
- Once a specific bar is selected by clicking any part of the bar or the slider (indicated by the dotted rectangle around the bar),
    - Right/Down [Left/Up] arrow moves the slider to the right [left] by 2.
    - PageDown [PageUp] key moves the slider to the right [left] by 21.
    - Home key moves the slider to the position 0; End key moves the slider to the position 100.

Now, complete all 20 sliders. You may use a mouse and a keyboard in any way you want to move the sliders. Try different techniques and find the one that works best for you.

Each session will begin with a trial period. You will have 45 seconds to complete as many slider tasks as you can. If your assigned role is a worker, your performance during the trial period will be used to determine your position in the queue for the matching in the first period. That is, you can increase your chance of getting a position of your choice by completing more sliders during the trial period because that will put you ahead of other workers. Your assigned role will be disclosed after the trial period.

Following the matching, workers will complete as many slider tasks as they can within 45 seconds. Workers will be paid according to the number of sliders they complete. Firms will earn profits according to the number of sliders their employee(s) complete.

The rate for slider tasks will be determined for each worker-position pair in each period as follows:

- If the pair is a good match,
    - 4/5 chance of getting a good rate (25 points/slider)
    - 1/5 chance of getting a bad rate (5 points/slider)
- If the pair is a bad match,
    - 1/5 chance of getting a good rate (25 points/slider)
    - 4/5 chance of getting a bad rate (5 points/slider).

Example:
Suppose the rate for the first period was 25 points and a worker completed 10 sliders during the first period. The worker and his/her employer earn 250 points each in the first period. Suppose the rate for the second period was 5 points and a worker completed 9 sliders during the second period. The worker and his/her employer earn 45 points each in the second period.

3. Dissolving Employment Relationships

At the end of each period, workers and firms are asked if they want to continue the current employment relationship(s) or dissolve the relationship(s). Employment will only continue if **both** the worker and the firm choose to continue the current employment relationship. In other words, either a "quit" decision by the worker or a "fire" decision by the firm will terminate the relationship.

In addition to these choices, all employment relationships are subject to **random termination**. At the end of each period, each relationship is randomly terminated with probability **1/10** regardless of the choices made by workers or firms.

Appendix B: Instruction for Ex-Post NCA Treatment

1. Forming Employment Relationships

Firm's Decision:
At the beginning of a period, each firm decides whether or not to offer each unfilled position in the labor market, and if offering, whether or not to impose a Contract X. Note that firms cannot offer positions that are already filled.

Workers will not be able to tell which position has imposed a Contract X. Workers learn a presence or absence of Contract X only after taking a position. Once a worker has accepted an offer, the worker is obligated to work for the firm for at least one period.

Suppose a worker accepts a position, and it turns out that the position imposed a Contract X. When the employment relationship is dissolved **for any reason**, the Contract X affects the worker's piece rate for **future periods**: the piece rate for the worker will be fixed at **5 points per slider** for the three (3) periods that immediately follow the termination of the employment. Note that this does not affect the piece rate of the new employer or the former employer who imposed the Contract X.

Each Contract X signed by a worker affects the worker's piece rate for the **three periods that immediately follow the termination of the employment**. Suppose a worker signs a Contract X in the 2^{nd} period and he or she quits at the end of the 3^{rd} period. Then the worker's piece rate will be fixed at 5 points per slider for the 4^{th}, 5^{th}, and 6^{th} period. If the worker signs another Contract X in the 4^{th} period and quit at the end of the 4^{th} period, this new contract affects the worker's piece rate for the 5^{th}, 6^{th}, and 7^{th} period. There is no extra penalty for being bound by two Contract X during the 5^{th} and 6^{th} period.

Worker's Decision:
Unemployed workers will be asked to rank the following actions according to their preferences:

- Take a position with a good signal;
- Take a position with a bad signal; or
- Remain unemployed.

Matching Algorithm:
After all firms with open positions and unemployed workers submit their decisions, the computer will match positions and workers according to the following algorithm.

First, all unemployed workers are sorted according to the number of sliders completed in the most recent period in which the worker was employed. The initial matching at the beginning of the session will be based on the number of sliders completed during the trial period. Ties are broken by flipping a coin (done by a computer).

Workers, from the top of the queue, i.e. those who completed the most sliders in the previous period, are assigned positions that best match their preferences, or remain unemployed if no available position satisfies their preferences. If there are more than one positions with the same characteristics of worker's

choice, the computer will randomly choose one. The selected position and the worker are matched. That position becomes unavailable to other workers. The computer chooses a position for the next worker in the queue from the remaining positions. This process continues until there is no position available or all workers are given an opportunity to choose a position. This matching process is automated by the computer.

Illustrative example:
Suppose there are three unemployed workers (worker 1, worker 2, and worker 3) and two positions submitted in the labor market (position C and position D) with the following characteristics.

	worker 1	**worker 2**	**worker 3**
Number of sliders	10	12	9
Signal from position C	Good	Good	Bad
Signal from position D	Bad	Good	Bad
Preference 1	Good signal	Good signal	Good signal
Preference 2	Unemployed	Bad signal	Bad signal
Preference 3	Bad signal	Unemployed	Unemployed

The worker queue looks like worker 2 – worker 1 – worker 3 because worker 2 completed the most sliders and worker 3 the least.

Worker 2's first preference is a good signal, and there are two positions available with a good signal. Suppose the computer randomly chose position C for worker 2.

Now, we continue on to worker 1. Worker 1's first preference is a good signal, but no position with a good signal is available because position C is already taken by worker 2. Worker 1's second preference is to remain unemployed, so he or she remains unemployed.

We continue on to worker 3. Worker 3's first preference is good signal, but no position with a good signal is available. Worker 3's second preference is a bad signal, and position D has a bad signal. Thus, worker 3 chooses position D.

The final assignment is as follows: worker 1 is unemployed, worker 2 takes position C, and worker 3 takes position D. When the assignment is informed to workers, they will learn whether or not they have to sign a Contract X.

Appendix C: Instruction for Ex-Ante NCA Treatment

1. Forming Employment Relationships

Firm's Decision:
At the beginning of a period, each firm decides whether or not to offer each unfilled position in the labor market, and if offering, whether or not to impose a Contract X. Note that firms cannot offer positions that are already filled.

Workers will be able to tell which position has imposed a Contract X.

Suppose a worker accepts a position that imposes a Contract X. When the employment relationship is dissolved **for any reason**, the Contract X affects the worker's piece rate for his or her future employment: **the piece rate for the worker will be fixed at 5 points per slider for the next three (3) periods** regardless of the quality of the match. Note that this does not affect the piece rate of the new employer or the former employer who imposed the Contract X.

Each Contract X signed by a worker affects the worker's piece rate for the **three periods that immediately follow the termination of the employment**. Suppose a worker signs a Contract X in the 2^{nd} period and he or she quits at the end of the 3^{rd} period. Then the worker's piece rate will be fixed at 5 points per slider for the 4^{th}, 5^{th}, and 6^{th} period. If the worker signs another Contract X in the 4^{th} period and quit at the end of the 4^{th} period, this new contract affects the worker's piece rate for the 5^{th}, 6^{th}, and 7^{th} period. There is no extra penalty for being bound by two Contract X during the 5^{th} and 6^{th} period.

Worker's Decision:
Unemployed workers will be asked to rank the following actions according to their preferences:

- Take a position with a good signal that imposes a Contract X
- Take a position with a bad signal that imposes a Contract X
- Take a position with a good signal that does not impose a Contract X
- Take a position with a bad signal that does not impose a Contract X
- Remain unemployed

Matching Algorithm:
After all firms with open positions and unemployed workers submit their decisions, the computer will match positions and workers according to the following algorithm.

First, all unemployed workers are sorted according to the number of sliders completed in the most recent period in which the worker was employed. The initial matching at the beginning of the session will be based on the number of sliders completed during the trial period. Ties are broken by flipping a coin (done by a computer).

Workers, from the top of the queue, i.e. those who completed the most sliders in the previous period, are assigned positions that best match their preferences, or remain unemployed if no available position

satisfies their preferences. If there are more than one positions with the same characteristics of worker's choice, the computer will randomly choose one. The selected position and the worker are matched. That position becomes unavailable to other workers. The computer chooses a position for the next worker in the queue from the remaining positions. This process continues until there is no position available or all workers are given an opportunity to choose a position. This matching process is automated by the computer.

Illustrative example:
Suppose there are three unemployed workers (worker 1, worker 2, and worker 3) and two positions submitted in the labor market (position C and position D) with the following characteristics.

	worker 1	**worker 2**	**worker 3**
Number of sliders	10	12	9
Signal from position C	Good	Good	Bad
Position C imposes Contract X	Yes	Yes	Yes
Signal from position D	Bad	Bad	Bad
Position D imposes Contract X	No	No	No
Preference 1	Good signal with Contract X	Good signal without Contract X	Good signal without Contract X
Preference 2	Good signal without Contract X	Good signal with Contract X	Bad signal without Contract X
Preference 3	Unemployed	Bad signal without Contract X	Good signal with Contract X
Preference 4	Bad signal without Contract X	Bad signal with Contract X	Unemployed
Preference 5	Bad signal with Contract X	Unemployed	Bad signal with Contract X

The worker queue looks like worker 2 – worker 1 – worker 3 because worker 2 completed the most sliders and worker 3 the least.

Worker 2's first preference is a good signal without Contract X. There is no position with a good signal without Contract X. Worker 2's second preference is a good signal with Contract X. Position C satisfies these conditions. Thus, the computer assigns position C to worker 2.

Now, we continue on to worker 1. Worker 1's first preference is a good signal with Contract X, but no position with a good signal with Contract X is available because Position C is already taken by worker 2. Worker 1's second preference is good signal without Contract X. There is no position with a good signal without Contract X. Worker 1's third preference is to remain unemployed, so he or she remains unemployed.

We continue on to worker 3. Worker 3's first preference is good signal without Contract X. There is no position with a good signal without Contract X. Worker 3's second preference is bad signal without Contract X. Position D satisfies these conditions. Thus, the computer assigns position D to worker 3.

The final assignment is as follows: worker 1 is unemployed, worker 2 takes position C, and worker 3 takes position D.